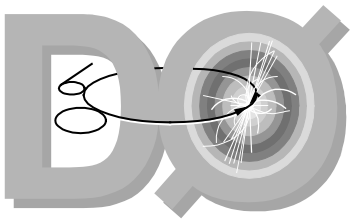

Calibration Goals for Run II Physics

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- Reminder of Run I Calibration
  - e.m.
  - hadronic
- E.m. Calibration Goals
  - W mass ,
  - $W \rightarrow e \nu$ angular distribution
  - Top mass (dielectron) ?
- Hadronic Calibration Goals
  - Top mass, Top physics
  - High E_T Jets, QCD
  - SUSY and other Searches
  - Higgs
- Conclusions

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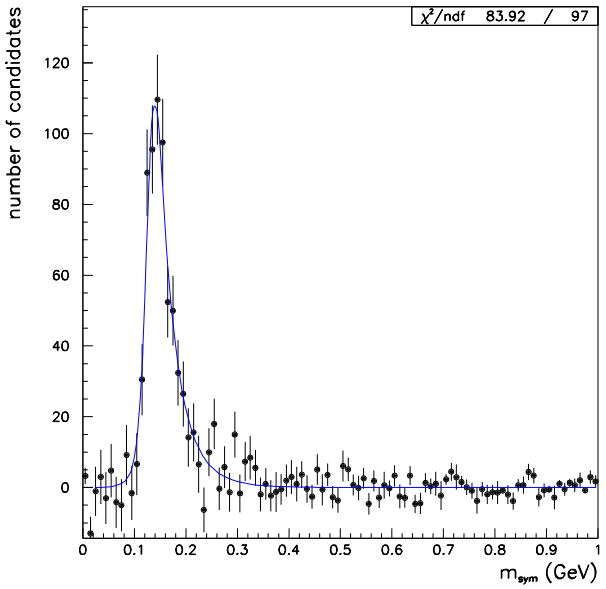
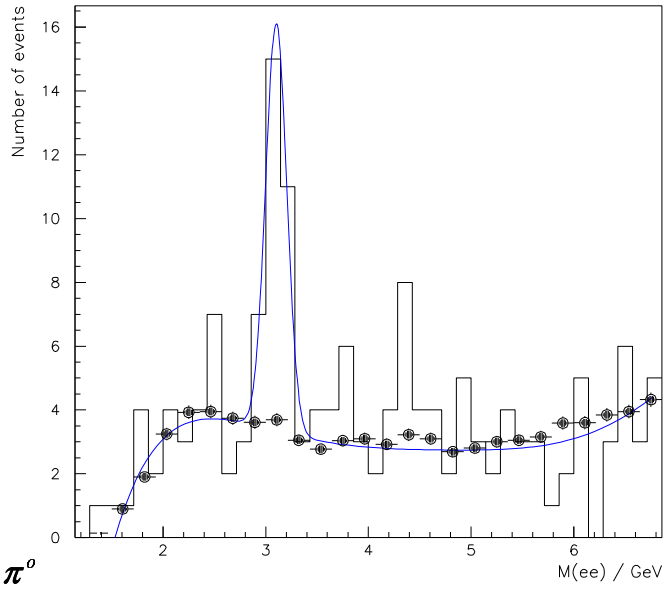
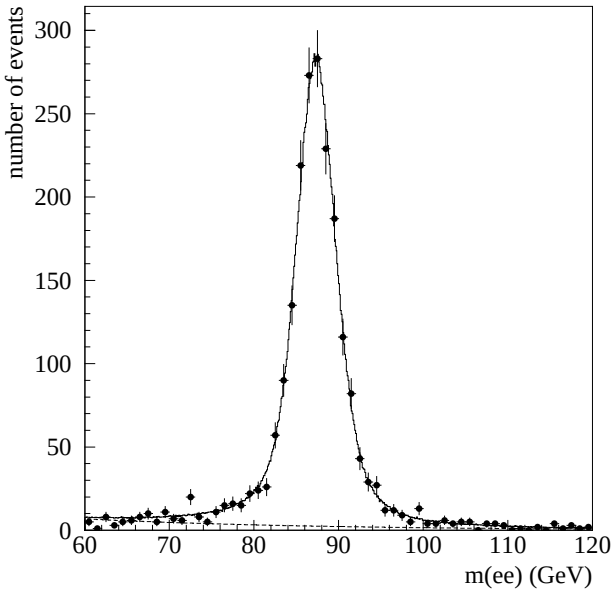
E.M. Calibration







Precise calibration determined at different energies, with different benchmarks:

π^0 , J/Psi, Z^0

E_rec= alpha*E_true+delta

alpha=0.9533 +- 0.0008
delta=160 MeV (+- 100)

Linearity error: <0.5%

Crucial change in Run II: dead material

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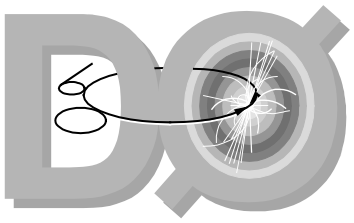

Hadronic Calibration

- Compensated Calorimeter
  - e resolution: 15%/ sqrt(E) +- 0.003
  - π resolution: 47%/ sqrt(E) +- 0.045
- Jet Calibration in several steps
  - remove e.m. clusters
  - subtract offset due to
    - noise
    - multiple interactions
  - correct for showering effects
  - intercalibrate with e.m. scale (γ+jet) (taking into account E and η dependence)
- In Run II: b-tagging and E/p

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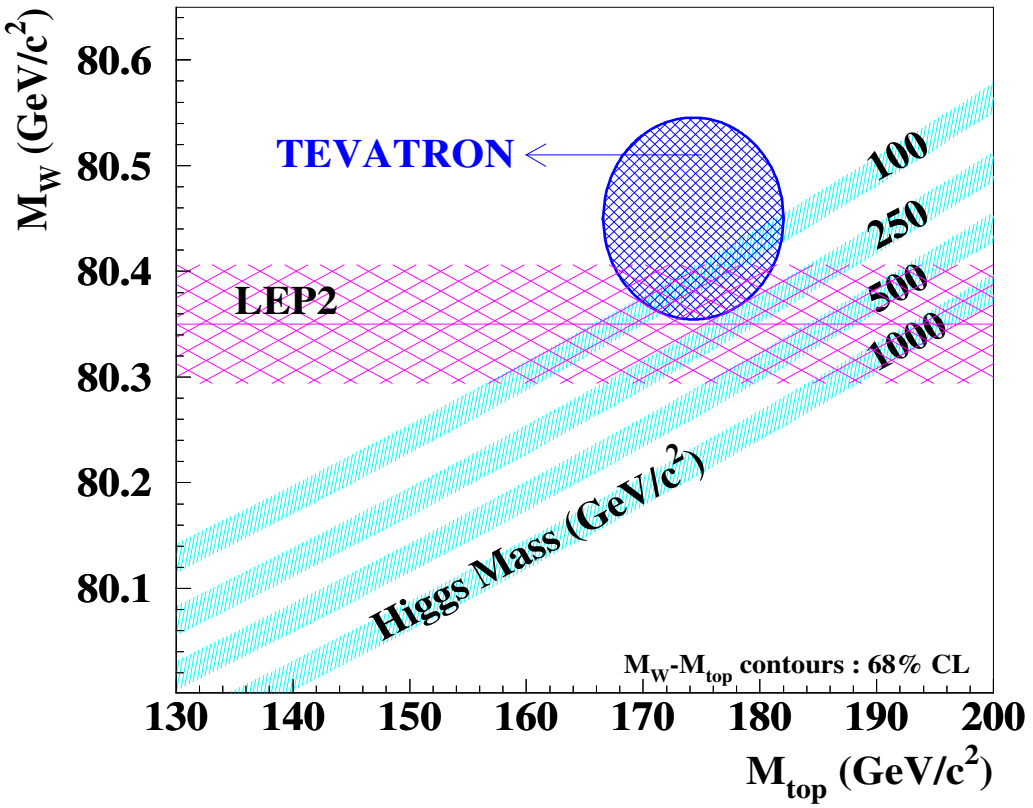
W Mass

- W mass (le benchmark)
  - 0.3 % on e.m. scale
  - linearity,uniformity,resolution
    - 35 MeV error out of 60 MeV det.syst.



    - 20 times increase in Lumi (IIa):
      - (20,10,25) ⇒ (10,5,10) MeV ?
    - 15 MeV calib error ?
  - -> 40 MeV W mass error?

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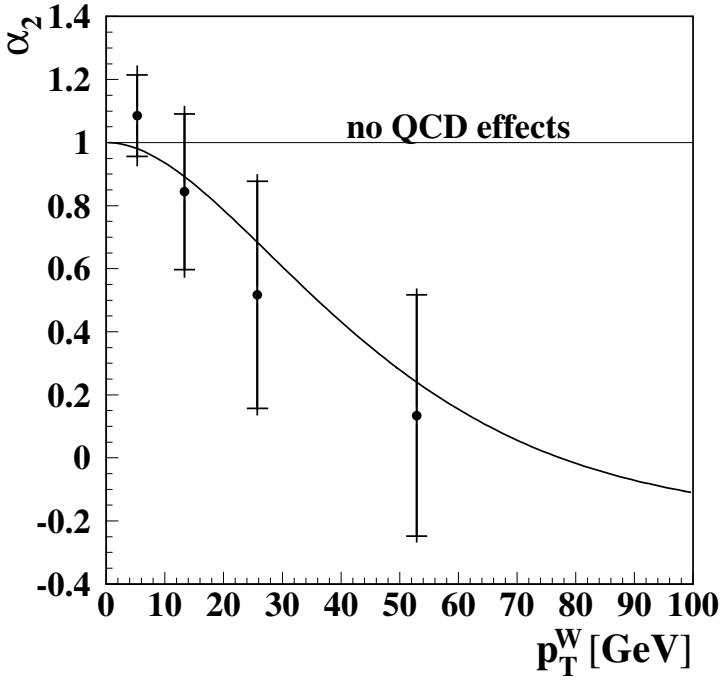
$W \Rightarrow e \nu$

- Angular Distribution of W decays
  - The V-A type distribution $(1 \pm \cos \theta^*)^2$ is modified by other QCD processes e.g. $q+g \rightarrow W + q'$, to become:

$$1 \pm \alpha_1 \cos \theta^* + \alpha_2 \cos^2 \theta^*$$

- Important to measure precisely -> W mass, test of QCD



- Systematics dominated by e.m. scale at low p_T^W decreasing towards high p_T^W, from :
  75% of the systematic error, down to 30%

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Top Mass (dielectron)?

- Error on e.m. scale (0.08 % at $E=M_Z/2$, 0.6% at 20 GeV) induces negligible error on the Top mass in the dielectron channel
- 2.5% error on the Muon momentum gives an error of 0.3 GeV on a total of 3.7 GeV systematic error.
- The total error is dominated by the error on the hadronic scale $\Rightarrow$ 2.4 GeV
  - Measurement presently dominated by the statistical error (12.3 GeV), but at run II, improvement on the jet energy scale will have a crucial importance:
- Best channel for Run 2a ??? or 2b???

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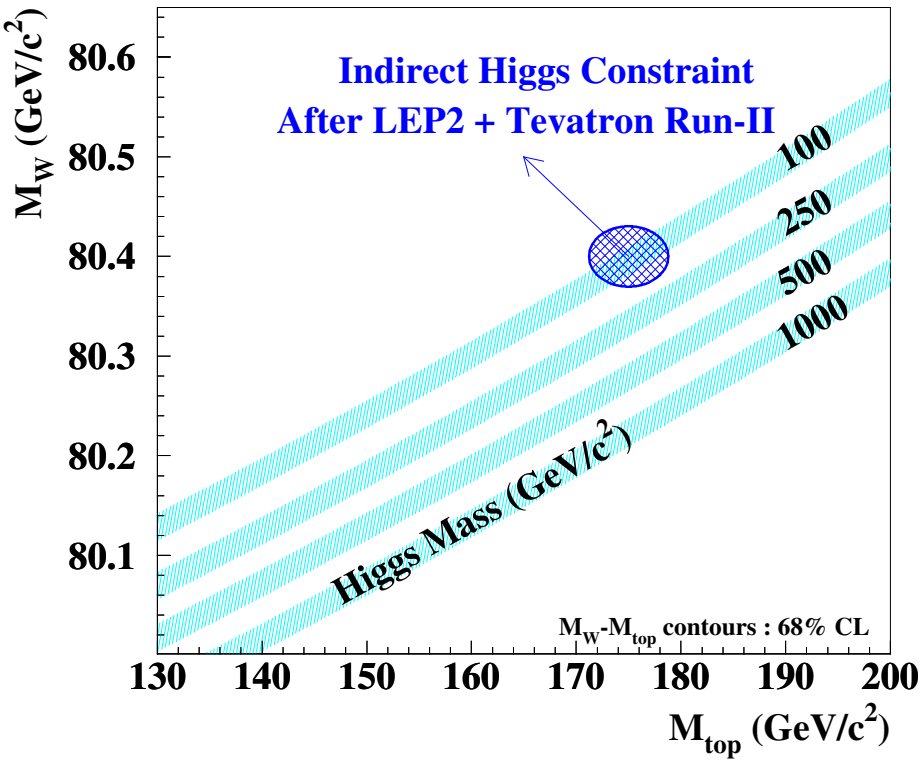
Top Mass, Lepton+Jets

M_{top}= 173.3 ± 5.6 (stat) ± 6.2 (syst)

- 2 major sources of systematic:
  - Modelling of the QCD background → (±4.1 GeV)
  - Jet energy scale: ±(2.5%+0.5 GeV) → (±4.0 GeV)

- Here also , higher Statistics and jet energy scale improvemenent can reduce significantly the error, down to 2 GeV for scale systematics.



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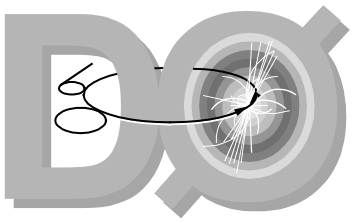

Top Mass All-Jets

- Comparison of systematic errors for the different CDF Top mass measurements:

	Lepton+Jets	All-Jets	Dilepton
Jet Energy Scale	4.4 GeV	5.0 GeV	3.8 GeV
Signal Model	2.6	1.8	2.8
MC generator	0.1	0.8	0.6
Background Model	1.3	1.7	0.3
Total	*5.3 GeV*	*5.7 GeV*	*4.8 GeV*

All -Jets channel syst. largely dominated by JES error.

Relatively low modelisation error; i.e. improvement of JES error renders it competitive (with b-tagging), especially since it has high statistics (44% BR into $q\bar{q}$), and no missing E_T.

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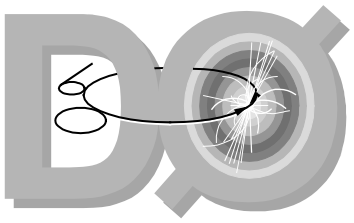

$t\bar{t}$ Cross-Section All-Jets

- Calibration errors are less crucial in total cross-section measurements (cf e.m. scale error influences only differential x-section)
  - All Jets prod. X-section systematic errors:

Background error:	13%	in which JES:	9%
Signal error	16%	in which JES:	6%
Total error	22%	in which JES:	11%

JES error is sizeable but not crucial

Major effects on differential cross-sections

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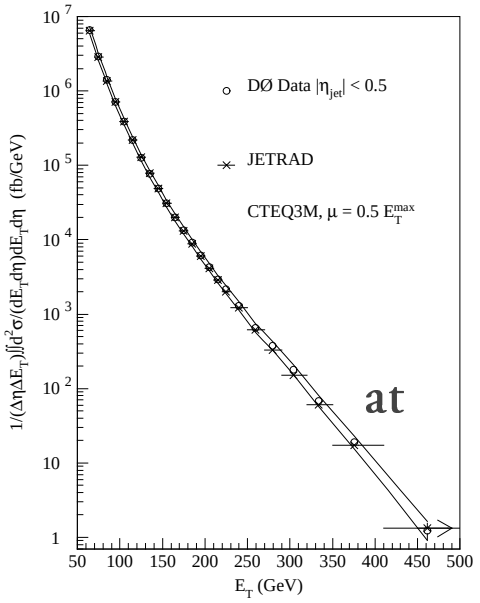
High E_T Jets, Perturbative QCD

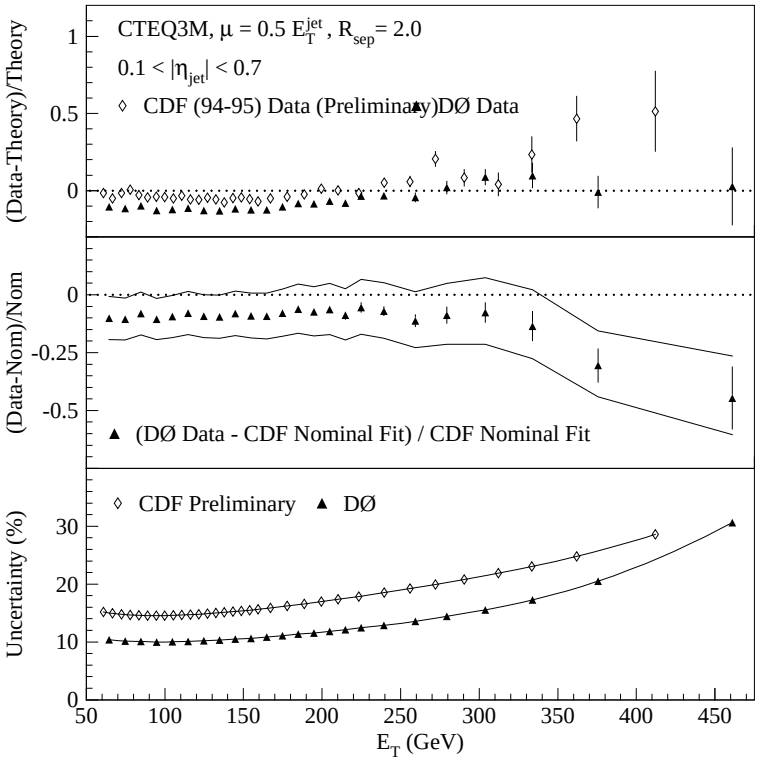
Inclusive Jet cross-section

- steep E_T spectrum is distorted by jet energy resolution
  - ▲ Unsmearing the data reduces reduces the x-section by 13% at 60 GeV.
- High end of spectrum can point to new physics!



•A reduction of the JES error by a factor of 2 will resolve the discrepancy D0-CDF and allow further QCD and BSM tests.

All differential cross-sections involving jets are crucially dependent on the JES, not on statistics



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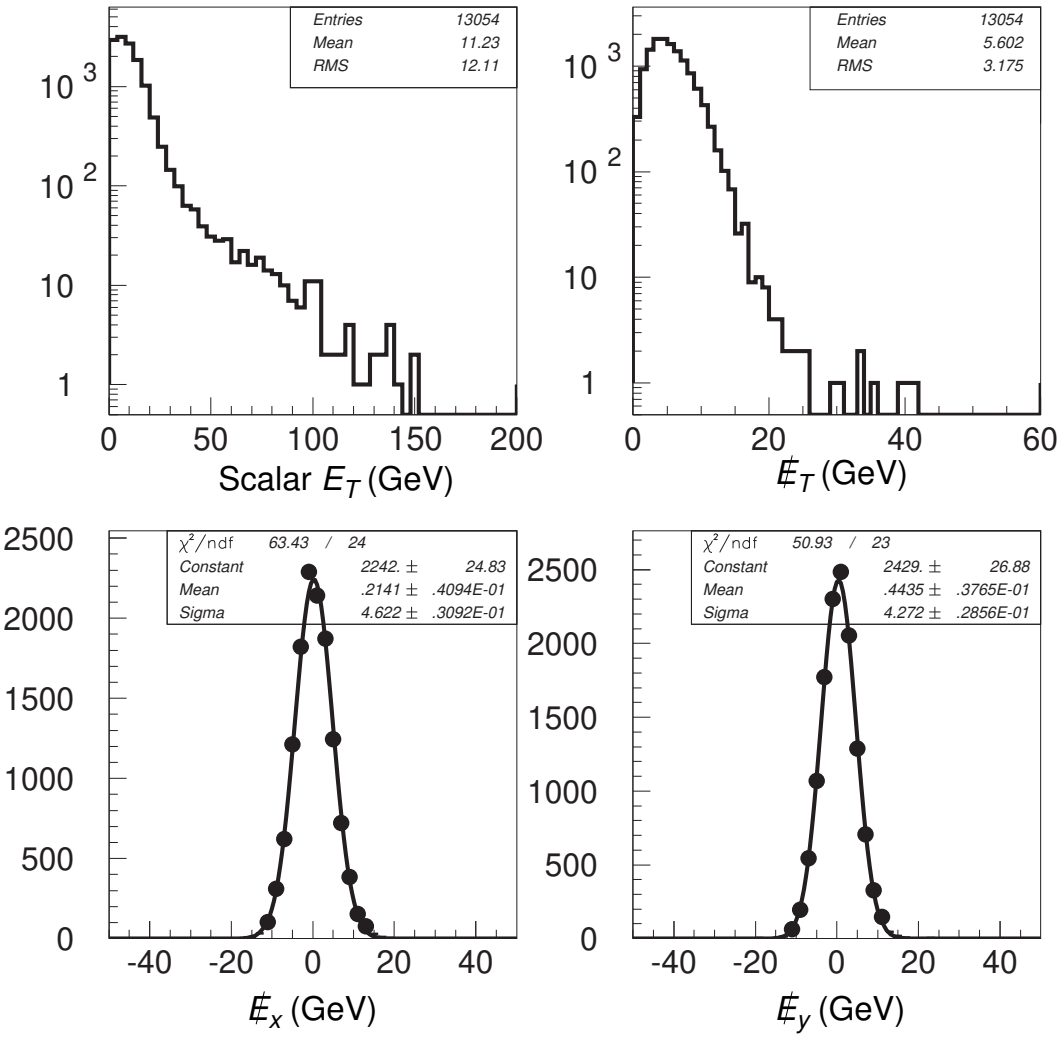
Susy and other Searches

Many signatures involve leptons, jets, E_t^{miss}

Calibration improvements are important for E_t^{miss} and for the jets, in order to reduce the QCD bckgd

Limits/discovery potential improve with lumi AND E_t^{miss} / jets resolution.



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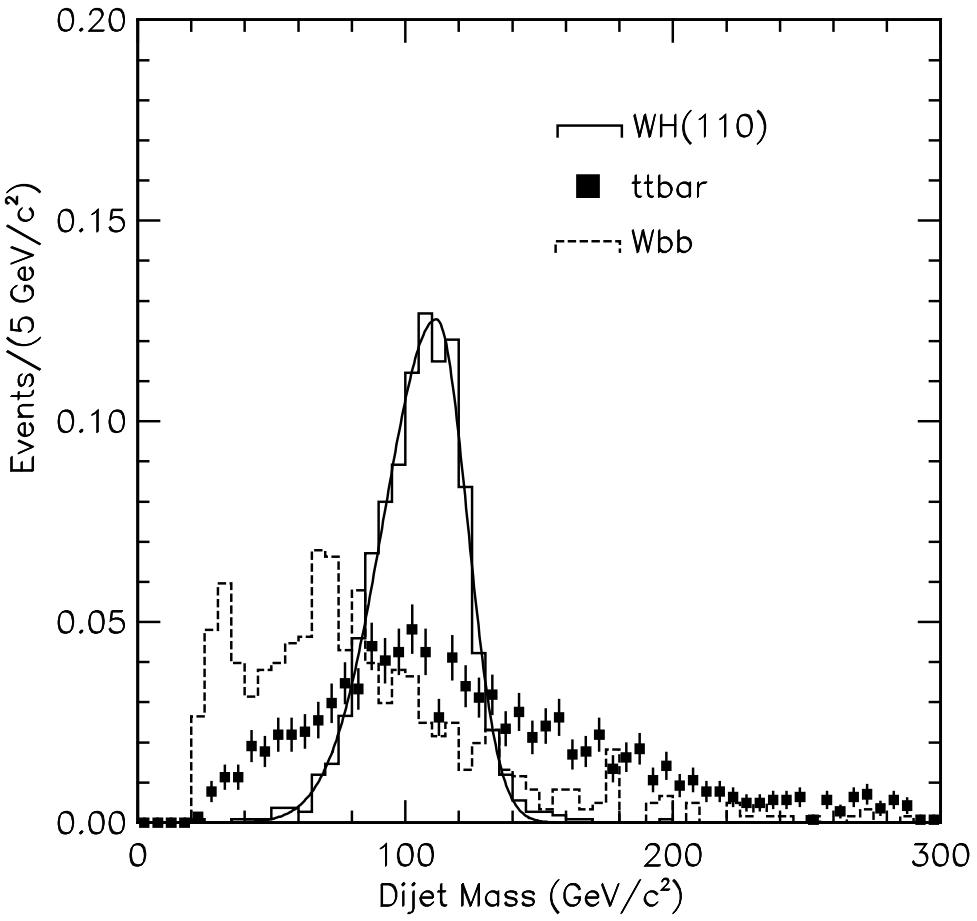
Higgs Search

If $M_{higgs} < 135$ GeV promising channel:

$$p\,\bar{p} \rightarrow WH \rightarrow l\nu\quad \bar{b}\,b$$

Signal to background depend crucially on $\bar{b}\,b$

mass reconstruction resolution



Can we go from 15% resolution to <10% ?

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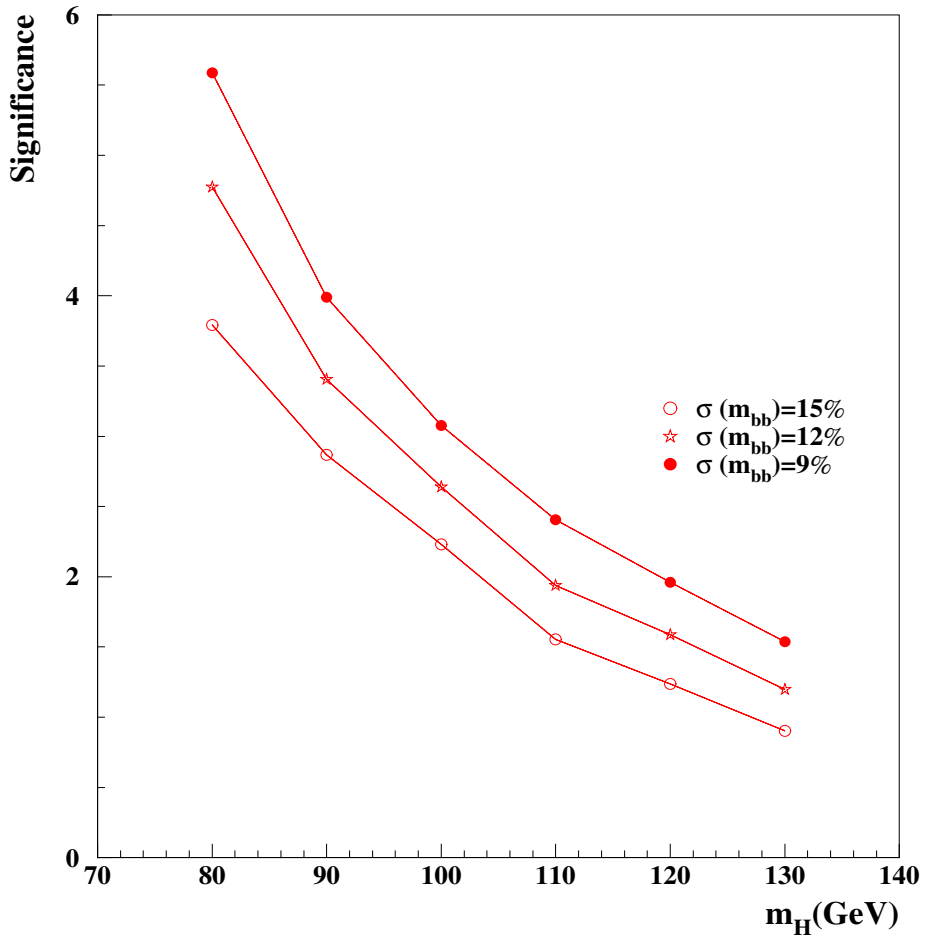
Higgs Search

Significance evolution with resolution at M_{higgs}=120 GeV

bb mass Resolution:	15%	10%
Signal events/fb^{-1}	4	4
Wbb	59	32
WZ	11	6
tt	34	24
single top	14	10



For 10 pb^{-1}

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Summary

• E.M. scale precision was excellent. Improve uniformity, linearity and resolution with high statistics, and correct for new dead material

Better W mass determination

• Improvement on the Jet Energy Scale error has the largest impact on the Run II Physics results, both for the precise measurement (Top mass, differential cross-sections etc..), and for the BSM searches (via the improvement on the Missing E_T resolution.

• The specific calibration of b-jets is also of crucial importance and needs a new and dedicated effort compared to Run I in D0. Maybe the Higgs…!!